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FOOD PRESERVATION AND FOOD TECHNOLOGY

THE Department of Food of the Government of India has constituted a Technical Panel of Scientists to advise the Department on the preservation and processing of food. Addressing the first meeting of the Panel, Sir J. P. Srivastava, Food Member to the Government of India, declared:

"The problem of food has during recent years engaged the increasing attention of almost all Governments in the world. And it is right that it should be so. Food is the very bedrock of a nation's life and well-being. It is the foundation on which practically all else is built. This is a truth which has long failed to receive the amount of recognition it deserves. Researches in the field of food and nutrition during the last two or three decades have shown how urgent and important this problem is. There is an increasing realisation that between optimum health and flank ill-health there is a considerable no man's land in which people may not be suffering from any obvious disease and yet may not be enjoying that standard of health and vigour which an optimum diet could have afforded them. Even in countries like Britain and the U.S.A. where the general nutritional level is considerably higher than in this country, practically half the population has been considered to be receiving a sub-optimum diet by this standard. In his message to the Hot Springs Conference the late President Roosevelt directed attention to this vital problem and stressed the fact that agriculture and food industries of the world still employed the vast bulk of the population of the world and required far greater consideration than they had so far received. The organization of the United Nation's Interim Commission on Food and Agriculture is a development in this direction. It is fitting that this problem should also receive organized attention in this country.

"The problem of food rests principally on three pillars:

(1) The production of raw foodstuffs;
(2) the food-technological industries including the preservation, processing and fortification of foodstuffs, vitamin technology and all related problems;
(3) the distribution of food to the population according to physiological needs.

Food Preservation

"It is with the second set of problems that you will be more specially concerned. Ours is mainly a tropical country, considerable parts of which have in addition a humid climate. These are ideal conditions for food-stuffs to undergo spoilage by insects, micro-organisms and also by normal biochemical processes. While exact figures are not available, our economic loss per year owing to the spoilage of foodstuffs of all kinds must be running into tens of crores of rupees. Ours is pre-eminently a country where food-technology should have reached a high-watermark of development. In Britain and in America, food industries are highly developed. In Britain there are institutions investigating food-technological problems, covering cereals, meat, fruits, fish, etc.; so also in America. These are in constant touch with food-industries, which are getting a higher goal for their standard of production as researches go on.

"It is clear that if countries enjoying a temperate climate, where the rate of spoilage is much less than in ours, take so much care in the preservation of their foodstuffs, our responsibility in this matter is much greater. Beginnings have been made in this country. The jolt of a war knocks off slumber. The question of prevention of spoilage of cereals is receiving much greater attention now than ever before. Canning of fruits has been started on a large scale in the North-West Frontier Province and we hope with increasing standardisation of fruits and further improvement of processing our standard will at least be equal to that of the best canned fruits of other countries. The development of the hydrogenated oil industry has received a great spurt during the war and we are at present engaged with the question of its further development on sound lines. The biscuit industry has been considerably expanded. Industries like those of pepper, mustard, golden syrup, sugar cubes, lime juice cordial, refined salt, etc., have been sought to be developed. It will be our earnest endeavour to see that these industries outlast the war. The problem of the production of vitamins and the fortifications of various foodstuffs with vitamins and minerals, as has been done in the U.K. and the

U.S.A. is before us. The question of food-yeast production from molasses is also receiving consideration.

DEHYDRATION AND REFRIGERATION

"The new industry of dehydration has been greatly developed as a result of the war. A considerable body of knowledge has been gathered in course of this development. It is for you and us to consider what part of this industry can be switched on to peace-time production. It is my earnest hope that the fruit dehydration industry which has started on a large scale in the N.W.F.P. may be established on sound lines and become a permanent feature of the food industry in this country. Dehydration of vegetables and fish has been carried out indigenously in village homes in various parts of the country for a long time and it is for you to consider whether, with the help of the knowledge now available about more scientific methods of dehydration, the old indigenous methods may not be improved or transferred to new lines. The food-packing industry is also an important one, to which I would like to invite your attention.

"Refrigeration is now considered to be the best method of preservation of perishable materials like fish, meat, vegetables, etc., and I would request you to consider this question also with reference to this country.

"The implications of a well-organized food industry are colossal. It is meant to (1) prevent or diminish spoilage, (2) remove foodstuffs from seasonal gluts thus preventing waste and making them available in other seasons, (3) increase or retain the nutritional value of foodstuffs, and (4) produce new foods like yeast, synthetic vitamins, vitamin concentrates, etc. Great things can and will be achieved by the application of science and technology to food. Food has even been produced from wood and during the present war, fats have been made from coal. I do hope by your joint endeavours with our technical experts, you will be able to help us in the development of a full-fledged food-industry in this country on scientific lines."

TATA MEMORIAL HOSPITAL FOR THE TREATMENT OF CANCER AND ALLIED DISEASES*

PHILANTHROPISTS are the back-bone of any enlightened community, and in India, the House of Tatas has perhaps no equal. The first triennial report of the Tata Memorial Hospital for Cancer shows what enlightened philanthropy could do for the alleviation of human suffering.

On the suggestion of Sir Frederick Sykes, the then Governor of Bombay, Sir Dorab Tata agreed early in 1932, to finance the establishment of a Radium Institute in Bombay. "As originally visualized, the scheme was on a modest scale, providing for the purchase of 400 milligrams of radium at an estimated cost of Rs. 2 lacs which included an endowment for its upkeep."

Owing to the unexpected demise of Sir Dorab Tata in 1932, the "duty of carrying through the project devolved on his Trustees". In order "to provide a worthy memorial to the spirit of enlightened philanthropy embodied in the persons of Mr. J. N. Tata and his two sons, Sir Dorab and Sir Ratan", the Trustees decided, after consultation with experts like Prof. Regaud of Paris, Dr. Patterson of Manchester and particularly Dr. Ewing of Memorial Hospital, New York, "to start a Cancer Hospital instead of a Radium Institute and equip it with the necessary adjuncts for surgery, X-rays and Radium—for, though a Radium Institute would undoubtedly supply an urgent want in Bombay, the type of service it would render would necessarily be restricted". "If its scope could be enlarged with a proportionate increase in the benefits conferred, the Trustees were of opinion that the much greater expenditure involved in building and maintaining a Cancer Hospital would be justified". Thus came into being the best institution for the treatment and study of Cancer in the East, built and equipped at a cost of Rs. 4,000,000. It was opened on the 28th February 1941 and up to date, some 7,000 patients have had the benefit of the knowledge of the experts in the staff of the institution.

Its modest achievements detailed in the report, makes one hope that after the termination of the hostilities, the extension of the teaching and research programme envisaged, would "really contribute its share to the solution of the many problems that are encountered in the study of Cancer". Realisation of this aim would be possible, only if the best brains in pure science are attracted to the laboratory and given not only facilities, but what is more important, unfettered freedom.

Cancer is a problem of the West while Leprosy is the problem of the East. Care of over five thousand Cancer patients in the course of three years is no mean record, but this pales into insignificance when it is realized that among us in India to-day, there are 1,500,000 lepers. One out of every three lepers in the world is in India. Even the erudite refuse to consider this serious leper problem, owing to the horror and loathing instilled into every one, by generations of dread of the disease. The problem has to be tackled some time, if we wish to rid India of this foul disease.

When theology is unable to fit the lepra bacilli in any Cosmic Plan, when scientists during the past five decades have failed not only to discover a remedy but even to make out whether the bacilli seen in a lesion are living or dead, when all attempts either to cultivate the bacilli or to transmit it to laboratory animals have failed, and when it is impracticable to dream of either isolating all the infectious cases or of separating from leprous parents their children at birth and rearing them up under ideal conditions by legislative measures, it is up to organized philanthropy to encourage investigations on the disease, extend to the victims, the benefits of medical science and rear up children of leprous parents free from chances of infection.

One fervently hopes that the next great philanthropic venture of the House of Tatas would be an attempt to tackle the problem of Leprosy in India.

M. K. SUBRAMANIAM.

* "First Triennial Report," Bombay, 1945.

OBITUARY

SIR MARTIN ONSLOW FORSTER, F.R.S.

TO his wide circle of pupils, friends and admirers, both in India and abroad, the sad news of the sudden and unexpected death of Sir Martin Forster which occurred at his residence in the city of Mysore on 23rd May 1945 has come as a severe shock. He was seventy-two. A few weeks prior to his death, on 8th of May 1945, he sent for publication in *Current Science* a "connected story" of the Royal Society which has been posthumously published in the last issue of the Journal. He had informed his numerous friends in Bangalore that he had planned to stay there for a couple of weeks.

Sir Martin was born on the 8th of November 1872; he received his education at the Finsbury Technical College. His academic career was punctuated by the award of several research fellowships and scholarships; in 1894 he secured the research fellowship of the Salters Company; in 1899 he became Granville scholar at the University of London. In 1915 he was honoured by the Chemical Society by the award of the Longstaff Medal. In 1905, at the early age of thirty-three, he was elected a Fellow of the Royal Society. For about ten years (1902-13) he held the position of an Assistant Professor at the Royal College of Science, South Kensington. He served the Chemical Society as its Honorary Secretary during the period 1904-10 and was elected Vice-President, Institute of Chemistry for 1908-11.

During the last War when the British Dyestuff Industry was reorganised and consolidated, Sir Martin was invited to serve on the Directorate of the British Dyes Ltd. (1915-18). From 1918-22, he occupied the post of Director of the Salters Institute of Industrial Chemistry. He was elected President of the chemical section of the Edinburgh session (1921) of the British Association for the Advancement of Science; his presidential address to this meeting bears the imprint of his discipleship under Emil Fischer.

During one of his visits to England, Sir Dorab Tata extended a personal invitation to Sir Martin Forster to accept the Directorship of the Indian Institute of Science, Bangalore. The administration of the Institute had, for some time past, been the topic of adverse criticism both from the public and the press; a committee of enquiry, presided over by Sir William Pope, had just issued its report and published its recommendations for the future working of the Institute. The Institute, at that time, needed a gifted administrator of far-sighted vision and outstanding ability, endowed with a sympathetic understanding of the special needs of the country. Sir Martin Forster accepted the invitation of Sir Dorab and took charge of the Institute as Director on 3rd November 1922.

The reorganisation of the Institute during that critical period was an extremely delicate and difficult task. Sir Martin had to steer clear of the strongly entrenched vested interests on the one hand and on the other, a critically-minded public who were agitating for a thorough overhaul of the administration of the Institute. With characteristic skill and determination, Sir Martin set himself to the task of reforming the Council and overhauling the staff; he brought about a "miracle" in the administration and the tutorial and research activities of the Institute. He was fortunate in securing the willing and enthusiastic co-operation of his colleagues—the late Professor Catterson Smith, Professors Norris, Simonsen and Watson—a brilliant team, who, under the inspiring leadership of Sir Martin, expanded and modernised their respective departments.

Sir Martin's Directorship, which covered a little more than ten years, marks an eventful era in the history of the Institute, distinguished by scientific achievement and technological progress. New courses, *e.g.*, Communication Engineering, were inaugurated; fresh lines of research were initiated; the necessary funds and facilities were freely and abundantly made available to the scientific investigators; Sir Martin raised the prestige of the Institute,

founded an edifice of liberal traditions of the highest academic life, created an atmosphere of confidence and contentment, and inspired the young men who passed through the Institute during the period to build up the qualities of courageous leadership and professional integrity. His greatest contribution to the scientific and industrial advancement of this country is the successive generations of young men who passed through the Institute; these are now filling positions of responsibility and trust throughout the country.

Sir Martin relinquished the Directorship on 31st March 1933 and at the gracious and kind invitation of the late His Highness the Maharaja of Mysore, he settled down in the peaceful and lovely environments of the Garden City of Mysore. During the period of his retirement he placed himself at the disposal of those who sought his counsel and help. He continued to take a keen interest in the affairs of the Institute. He was invited to serve on the Council of the University of Mysore and on the Advisory panel of the Board of Scientific and Industrial Research of the Government of Mysore.

Current Science owes its inception largely to his genius and foresight; he presided over the inaugural meeting convened to consider the founding of the Journal and conducted the proceedings with great tact and deep sympathy. He was intimately and actively connected with the progress of the Journal whose pages he has enriched with his editorials, reviews and notes on important questions of the day.

Almost to the end, he kept himself active and alert; those of us who saw him a few weeks before his death could hardly have imagined that his end was so near. In his death, we have lost a sincere friend, an outstanding chemist, an inspiring teacher, a sympathetic adminstrator and a great gentleman. His pupils and colleagues will for long cherish his memory with gratitude and affection.

DR. STANLEY KEMP, F.R.S.

THE death of Dr. S. W. Kemp, Director of the Marine Biological Laboratory at Plymouth, on the 16th of May, has removed one of the foremost figures in the field of marine biological and fishery investigations in the British Commonwealth.

Kemp was born in 1882 and was educated at the St. Paul's School, and at the Trinity College, Dublin. He began his scientific career as Assistant Naturalist to the Fisheries Research Section of the Department of Agriculture and Technical Instruction, Ireland, which he joined in 1903. Investigation of the fauna of the Irish seas was one of the main problems of the Department and it was there that Kemp began his series of studies on the Crustacea, a group in which he subsequently became an outstanding authority. With the re-organization of the Indian Museum at Calcutta, he joined its zoological section in 1910 as the Superintendent. The constitution of the Zoological Survey of India which followed and the active collaboration of Kemp and the then Director, the late Dr. Annandale, was a period of great expansion of the activities of the Survey which produced the most fruitful results in the study of the Indian fauna. The development of the different sections of the Museum and of its two scientific journals, the *Records* and the *Memoirs*, owes much to the enthusiasm and energy of Kemp. His scientific work was on the taxonomy of Indian Crustacea, mainly the Decapoda, but in addition he devoted much time to the biological surveys of the Chilka Lake and of the Siju Cave in Assam, sharing the same enthusiasm and versatile qualities of his friend and chief, Annandale. During the Abor Punitive Expedition (1911-12) he was attached to the party as the Zoologist and Anthropologist. The expedition led to the discovery of Peripatus (*Typhloperipatus williamsoni* Kemp) on the north-eastern frontier of India at the foot of the Himalayas.

Kemp's connexion with the Zoological Survey was cut short when in 1924 the Colonial Office constituted the Discovery Committee which he joined as the Director of Research and led the second Discovery Expedition to the Antarctic. After his return he was fully occupied with the co-ordination of the results of this Expedition in relation to Whale Fisheries and the editing of the series of Scientific Reports. He was elected a Fellow of the Royal Society in 1931 and he presided over the Zoological Section of the British Association in 1937.

In 1936 the late Dr. E. J. Allen after a most distinguished period of Directorship of the Plymouth Laboratory for over 42 years expressed his desire to retire and Kemp was chosen as his successor. It is in this official position that his organizing abilities and broad vision in regard to scientific development found their full expression. Extended facilities for visiting workers and the staff were provided in a new scheme of expansion which Kemp carried out in 1939 and in the summer that preceded the outbreak of the Second World War there were no fewer than forty visiting scientific workers at the Plymouth Laboratory.

The outbreak of war created many problems for continuing the work of the laboratory but the crisis came in March 1941 when much damage to both building and equipment was done by the successive air-raids on Plymouth. Kemp himself was the worst sufferer for he lost all his personal possessions and his library along with much of his unpublished work. Through those difficult months that followed he steered the Institution with great courage and determination, losing no time to have detailed plans drawn up for the reconstruction of the Laboratory as soon as times permit rebuilding. His great ambition was to develop Plymouth into a strong nucleus for fundamental research on and training in fishery problems during the post-war period.

In regard to India he maintained an active interest in the problems relating to fishery work and did much to focus attention on this important aspect of National Planning. The last few months of his life were devoted to building up a strong organization for promoting Fisheries Investigations in the different countries of the British Commonwealth. His death is a great loss to the scientific world at a time when his mature judgment and counsel would have been invaluable in the drawing up of schemes for post-war reconstruction.

N. K. PANIKKAR.

COPPER-CUPROUS OXIDE RECTIFIER

By K. R. Dixit
(*Gujarat College, Ahmedabad*)

NUMEROUS "Sperrschicht Cells" or "Barrier layer" rectifiers are in commercial use; but no material appears to have been more extensively studied or utilised than the copper-cuprous oxide rectifier. These rectifiers satisfy the demands for the direct current and are used in battery-charging, in electroplating, in preparing A.C. measuring instruments, in telecommunications and as photo-electric cells. The practice has far outrun our knowledge of the fundamental nature of the problem and we are forced to follow the trial-error and inferential methods of procedure. Our present knowledge appears to indicate that the rectification is governed by statistical laws. Scientific interest has been stimulated mainly by the ever-increasing use of the effect in industry. We have undertaken to study systematically the various factors which alter the rectification of cuprous oxide layers, with a view that such a systematic knowledge will enable us to understand the mechanism of the rectifying action. This paper gives a short summary of the work we have done so far, but for the sake of giving the readers a complete picture we have included some work done by others.

In general when voltage is applied to a conductor the current which flows is independent of the direction of the voltage. But some composite conductors show asymmetric conduction, that is, the property of passing currents more freely in one direction than in the opposite direction. The direction in which more current flows is usually called the forward or the conducting direction and the other the reverse or non-conducting direction. The rectification occurs at the contact between the two dissimilar substances.

In 1926 Grondahl observed that a plate of copper upon which a thin film of cuprous oxide has been formed could be used for the rectification of currents of considerable magnitude. The rectifier was made by partially oxidizing a sheet of copper in air at about 1000° C. and then by allowing the oxidized sheet to cool to room temperature. When one electrical contact was made to the copper sheet and another to the oxide by a metal foil applied under pressure, it was found that the elelment passed current readily from oxide to copper but much less freely in the other direction. The process which is used to-day in preparing the cuprous oxide rectifier is similar to the Grondahl's original process.

For best effects the copper needs to be of exceptional purity, it was supposed at one time that it should be completely free from silver but later experiments have disproved this. Since it is the surface of the metal which is used in making the rectifier it is essential that it should be clean and with a perfect finish. Pure copper (to which suitable amounts of inclusions can be added) is poured in a molten state, then it is rolled (or hammered) in strips of 1 mm. thickness, from this is punched the blank to be oxidized. It is established that grain-size, hardness, etc., are of no importance. There is no test of the suitability of rectifier copper other than the preparation of rectifiers from it.

The blanks are oxidized in pure air at about 1020° C. Cupric oxide formed at lower temperatures becomes unstable at 970° C. and is reduced to cuprous oxide. The furnace tempenature must not exceed 1040° C. Upto an oxidation temperature of 1020° C. the higher the temperature the lower the forward resistance of the rectifier. The temperature of the furnace is allowed to remain at 1020° C. for about 12 minutes and an oxide film of about 0·1 mm. thickness is formed. The annealing is done in two stages upto 600° C. in 15 minutes in the furnace and then it is removed and cooled to the room temperature. Some physical deformation is produced, in the oxidizing and annealing process, but if copper is oxidized on both sides the element remains flat. The cuprous oxide is in the form of a hard bright red crystalline layer adhering very firmly to the mother copper but covered by a very thin film of black cupric oxide which has been formed during annealing. The insulating film of black oxide was originally removed by mechanical means, but later a concentrated solution of sodium cyanide was employed, now this has been superseded by a mineral acid process. These changes have been accompanied by marked improvements in the magnitude of the reverse resistance. If now an efficient electrical contact is made with the cuprous oxide the rectifier element becomes ready for use. If a soft metal is simply pressed in contact with the oxide layer the contact resistance is very high; so powdered carbon is rubbed into the surface and a soft metal foil is pressed on. Or colloidal graphite in aqueous suspension is painted on the surface and is dried; contact may be made with graphite either by soft metal under pressure or by spraying, vaporising or cathode sputtering a metal electrode which gives good contact without the use of pressure.

The resistance of the rectifier either in the forward or reverse direction depends on the applied voltage, that is, the rectifier does not obey Ohm's law. The resistance varies with the applied voltage, temperature and time. The most important electrical property of a rectifier is its self-capacitance which is of the order of 0·02 μF. per cm.^{2} This value varies with the voltage and current in the rectifier but is practically independent of the frequency. The capacitance has the effect of increasing the reverse leakage when the rectifier is used at high frequencies. The electrical properties of the rectifiers can be varied considerably at the will of the manufacturer.

Cuprous oxide layer formed in this way exhibits photoconducting properties and can be used as a cell showing photovoltaic effects. In the normal cuprous oxide rectifier, when

light falls upon the oxide surface the photo-current flows from copper to oxide internally, that is, in the reverse direction, and it may be expected that the magnitude of the current would be related to the reverse characteristic of the rectifier. There is, however, no evidence to support this. The cell has a red and infra-red colour response and the cut-off at the end of the visible spectrum corresponds exactly to the commencement of the light transmission of the cuprous oxide, which, therefore, must be acting as a filter. Maximum colour response is approximately in the middle of the visible spectrum.

SPERMATELEOSIS AND NUCLEINATION

By B. R. SESHACHAR

(Department of Zoology, Central College, Bangalore)

SINCE the early studies of Mieschер[1] followed by those of Steudel and Peiser[2] on the chemical constituents of the sperm-heads, it has been known that these, which represent so far as we know, the consolidated essence of nuclear matter, contain a large percentage of nucleo-proteins which make up much of the chromosomes of the nucleus. In fact, our knowledge of the chemistry of the nucleus has largely been based on these pioneer studies, and as a result, it has now been clear that the chromosomes are in the nature of complex salt-like compounds of proteins and nucleic acids called nucleo-proteins. The two conditions of the nucleus, that of rest and that of division, differ mainly in the polymerization of nucleotides on the protein framework of the chromosomes. It is surmised that most, if not all, nucleic acid of the chromosome comes from the cytoplasm where it exists as isolated nucleotides and which are transferred to the chromosomes at the beginning of every mitosis. In fact, one of the important changes associated with mitosis is the nucleination of the chromosomes, whose fixability, and visibility under the microscope are due to the accumulation of nucleotides on the protein framework of the chromosome, which is the permanent part of the chromosome, the nucleic acid varying in amount at different stages of the mitotic cycle. It has even been suggested that the sudden increase of nucleic acid in the chromosomes at pro-metaphase of mitosis is due to the breaking down of the nuclear membrane at this stage and the free transference of material from the cytoplasm to the chromosomes (White[3]). So the idea has gained ground that the mitotic process is a necessary prerequisite for the organization of the chromosomes in a recognizable form, and for their nucleination. For, at no other stage the chromosome is visible in the nucleus, nor is thymonucleic acid identifiable in the nucleus at any other time.

But that leaves the sperm-head, which has formed the important source of our information on the chemistry of the chromosome, out of the picture. The sperm-head is analogous to the metaphase chromosome in that it represents the synthesis and accumulation of the maximum amount of nucleic acid in relation with the protein; but while in the latter case, this synthesis has been achieved with reference to mitosis, in the former, the synthesis of nucleic acid has taken place without any reference to division and indeed, without any reference to the chromosomes. The sperm-head, therefore, offers the only example of the synthesis and accumulation of desoxyribose nucleic acid outside its relation with the definitive chromosome.

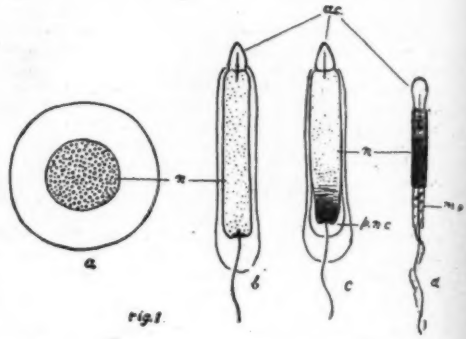

FIG. 1. Four stages in the spermateleosis in *Ichthyophis glutinosus*. × 600.

a. Resting nucleus of the spermatid.

b. Elongation of the nucleus during spermateleosis.

c. Beginning of nucleination from the posterior end.

d. Fully formed spermatozoon.

ac. acrosome; *m.p.* middle piece; *n*. nucleus; *p.n.c.* post-nuclear cavity (which later becomes the middle piece).

The process of spermateleosis confirms this. The animal spermatid has a resting nucleus, and associated with changes which vary in different animals, this nucleus begins gradually to synthesize nucleic acid within it till in the fully formed sperm, the nucleus is the packed essence of nucleo-protein. If the mitotic cycle involves the transference of cytoplasmic nucleotides into the nucleus and their conversion from ribose to desoxyribose nucleotides, then the same process must take place during spermateleosis also, where, however, without changes associated with mitosis and without the formation of organized visible chromosomes, the essentials of the same process of deposition of desoxyribose nucleic acid takes place in the nucleus.

There is yet another parallel between the development of the metaphase chromosome and that of the spermatozoon. In both it is probable that important changes occur in the

protein constituents. Miescher himself showed that the metaphase chromosome, like the sperm-head, contains only simple proteins of the histone and protamine types associated with desoxyribose nucleotides, the higher globulin types of proteins breaking up during mitosis and spermateleosis respectively (Miescher,[1] Darlinghon,[4] Caspersson[5]). But this similar end result is achieved in two different ways, in one case by the organization of the chromosome with which the nucleotides are associated, and in the other, without the formation of definitive visible chromosomes.

When we talk of condensation and consolidation of the nucleus during spermateleosis, it implies much more than a mere physical change. It means primarily, a reduction in nuclear volume brought about by an expulsion of water and nuclear sap. This reduction is often considerable as shown in the Apoda (Amphibia) by the author[6] where it may be as much as 95 per cent. But it also means another more important thing. It means the acquisition of nucleotides by the consolidating nucleus from the cytoplasm if they have to come from outside the nucleus; or if they have not, their production inside the nucleus itself. In this matter, whatever the condition in embryonic and meristematic tissues where cytoplasmic ribose nucleotides have been detected (White[3]), in the developing spermatid at any rate, their occurrence in the cytoplasm in any large quantity is highly improbable. The amount of cytoplasm in a developing spermatid (of the Apoda, for instance) is so inconsiderable that the likelihood of there being any appreciable quantity of nucleotides in it to contribute to the sperm-head is very little indeed. Spectroscopic observations in certain tissues have shown the relative paucity of nucleotides in the nuclear sap (White[3]) but in view of the foregoing it would be interesting to examine by spectroscopical analysis, developing spermatids.

Wherever the nucleotides come from, either from the cytoplasm or the nucleus itself,—and the former possibility is very remote,—their original reactions are such that in the early spermatid they are of the ribose type and as in mitosis, they are converted into those of the desoxyribose type in the fully formed sperm-head.

There is yet another curious relationship between the chromosome and the sperm-head to be considered. The reproduction of the chromosome during mitosis (and meiosis) is dependent on the acquisition by the protein framework of a minimal quantity of nucleic acid charge. It is admitted that it is probable that here is involved not only a quantitative relationship between the protein and the associated nucleic acid but also a relationship of *arrangement* of the desoxyribose nucleotides with reference to the protein framework. In any case, assuming that the synthesis of nucleic acid in the nucleus has an important bearing on the reproduction of the protein framework of the chromosome, the synthesis of nucleic acid in the nucleus of the developing spermatid unattended by any attempt at or evidence of reproduction is full of interest. It is highly probable that the whole relationship of the protein and nucleic acid is a different one in the sperm-head from that in the mitotic chromosome. This itself is a matter of considerable interest, for by two essentially different vital processes, the synthesis of nucleic acid can take place in animal cells, (1) by mitosis and (2) by spermateleosis. This would impart a wholly different complexion to the process of spermateleosis and make the spermatozoon a highly specialised cell in more than one respect.

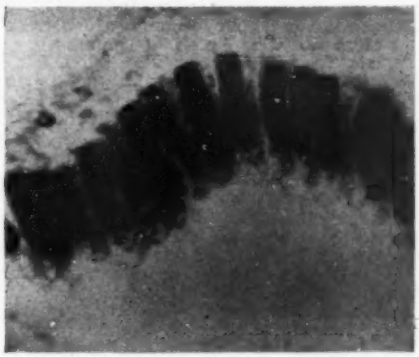

FIG. 2. Microphotograph of the developing spermatids of *Ichthyophis glutinosus*, showing the beginning of nucleination. × 1500.

The details of the process of nucleination of the spermatid nucleus are full of interest in this connection. In the Apodan spermatid with which the author[7] is particularly well acquainted, the following briefly are the facts: The spermatid nucleus is at first spherical and is in the resting condition. It gradually assumes an elongated cylindrical form and at the same time becomes fainter in its staining capacity. When this elongation has reached its maximum (which varies in the different species of Apoda examined) the nucleus begins to contract in length as well as in girth, and associated with this contraction in size is the beginning of the synthesis of thymonucleic acid. The nucleus, which till now was only very faintly staining, shows posteriorly a positive reaction with Feulgen and the narrowing nucleus gradually shows a deeper staining power. This synthesis of thymonucleic acid as evidenced by the staining reactions extends gradually forward till it pervades the entire nucleus, which now is narrower and shorter but a deeply staining cylinder. If we divide the nuclear history during spermateleosis in Apoda into two phases, the first phase is concerned only in the elongation of the nucleus, while in association with the second phase is a double phenomenon of shortening and consolidation as well as the synthesis of thymonucleic acid. By this time the cytoplasmic equipment of the elongated spermatid is so meagre that, as already observed, it is highly unlikely that any contribution of nucleotides

could be made by it. The staining reactions prove this. It is more probable, on the other hand, that the nucleotides in a ribose state exist within the nucleus itself and in the second phase of the nuclear history of the spermatid, are converted into those of the desoxyribose type.

Throughout spermateleosis there is a continuous process of concentration and reduction of the volume of the nucleus but while in the first phase, there is only reduction in volume, in the second, there is in addition, a synthesis of desoxyribose nucleic acid.

Much of the above account of spermateleosis refers to the Apoda (Amphibia) which illustrate the phenomenon admirably, but it is probable that other animals display much the same process.

It is, therefore, clear that nucleination, far from being associated *always* with division, occurs at least in one other condition, i.e., in spermateleosis, but in a fundamentally different relationship and unassociated with the formation of definitive visible chromosomes. Chemically and even quantitatively, the protein and nucleic acid of the metaphase chromosome may resemble those of the ripe spermhead, but in one case, the protein is a fibrous framework with which at certain localised areas, the nucleic acid becomes associated, while in the other case, no chromosomes are seen. In one case, the synthesis of nucleic acid is associated with division and in the other, it is unattended by division.

The subsequent history of the sperm nucleus is also interesting. After entry into the ovum, it exhibits reactions which fall under two different categories. In the sea-urchin, it becomes converted back again into a resting nucleus and from all existing accounts of the details of fertilization (Wilson[8]) it is in this condition that it fuses with the nucleus of the ovum. On the other hand, in Ascaris, soon after the entry of the sperm the nucleus almost immediately becomes organized into the definitive haploid number of chromosomes characteristic of the species, and in this condition, with the chromosomes distinct within the nuclear membrane, it approaches the female pronucleus. A spindle is soon formed —the spindle of the first cleavage division,— and on it by the dissolution of the nuclear membranes of the sperm and the ovum, the chromosomes are placed; so that in Ascaris no mingling or flowing together of the nuclear material is involved.

The difference between the sea-urchin and Ascaris would appear to lie in the interpolation in the former of a resting stage before the actual fusion of the sperm nucleus with that of the ovum.

The significance of this from our point of view is important. In the sea-urchin processes which are the reverse of what take place during spermateleosis must occur during the early stages of fertilization. Nucleination which occurred during spermateleosis is followed by denucleination during the early stages of fertilization, where the sperm nucleus gets back into the resting condition. Obviously this supports the view expressed earlier that spermateleosis is a remarkably unique phenomenon without parallel in any other aspect of cell life, where nucleination occurs with reference to the resting condition, and unassociated with division of the nucleus.

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THE INDIAN INSTITUTE OF ART IN INDUSTRY

THE Indian Institute of Art in Industry, which has, during the last five years, pioneered the art-in-industry movement, has been registered and invested with an All-India status. The Institute will have a secretariat in Bombay and representatives in other important centres. It aims at becoming "the central guiding force in the country's art applied to industry".

The Institute will develop the art in industry exhibitions and will also build up an annual industrial fair of goods of attractive appearance, and this will greatly stimulate trade in the immediate post-war period. The Institute will engage experts in commercial art and industrial design, and will assist in the training of teachers for government technical institutions. It is intended that as soon as possible a monthly magazine will be published, followed in due course by other types of bulletins. A register of commercial artists and designers will be compiled. The Institute will strive to become as rapidly as possible a valuable complement to industry in matters pertaining to design, packaging, and the various aspects of commercial art. It is understood that a substantial grant from the Central Government is now under consideration and it is hoped that Provincial Governments and Indian States will give generous support to the Institute. It is expected that a revenue of 5 lakhs of rupees will be forthcoming to enable the Institute to carry out its programme, and of this sum, it is estimated that two lakhs will be contributed by industrialists.

LETTERS TO THE EDITOR

THE FLUORSPAR DEPOSITS OF RAJ NANDGAON AND KHAIRAGARH STATES, EASTERN STATES AGENCY, CENTRAL PROVINCES

In this communication, attention is confined to the fluorspar deposits of the States of Raj Nandgaon and Khairagarh. These deposits were examined by Dr. Chhibber, while the collection was studied conjointly by him and Mr. I. C. Pandey.

There are two ways of approaching these deposits. One of them is *via* Raj Nandgaon and then a journey of 26 miles takes one to the deposits. They are also accessible from Dongargarh which is a railway station, about fifteen miles by road from these deposits.

Previous Literature.—There are passing references to this deposit by Thomas Oldham[1] and W. T. Blanford.[2] There is also a paragraph in the Director's Annual Report for 1938-39. Reference to this dposit is also made by Dr. M. S. Krishnan,[3] wherein it is stated that Dr. J. A. Dunn visited the deposit.

Physical Features.—These fluorspar deposits form two small hills running practically in a north-south direction and are separated by the Great Eastern Road. These hills rise from the surrounding flat granite country and the locality is locally called Chandi Dongri because of the association of the argentiferous galena with these deposits. The northern hill lies in the State of Khairagarh while the southern hill is situated in Raj Nandgaon State. The Khairagarh hill is about 70 feet above the level of the Road.

Geology.—The geology of the country is represneted by the following rock-types:—

(iii) Silicified Granite.
(ii) Fluorspar Pegmatite.
(i) Granite.

The country-rock is a porphyritic granite, clearly exposed in the streams. Outcrops of this rock are seen in places; otherwise it is covered with soil or subsoil, sometimes with a heavy over-burden. The following profile section was observed, in descending order, in a quarried face of the granite in the northern hill in the Khairagarh State:—

(1) Blackish soil mixed with gravel and humus in which pieces of fluorspar are occasionally found. It is about two feet in thickness.
(2) Reddish soil in which quartz grains are very conspicuous. It is locally known as *moorum*. It is lateritic in character and the felspar has changed into clayey material. It is about four feet in thickness.
(3) Below (2) decomposed granite is exposed in which felspathic veins are seen running in all directions.

Deposit of Fluorspar.—The locality, where fluorspar is known to occur, is locally known as *Chandi Dongri* (meaning silver hill) because of the association of argentiferous galena with the deposit. However, the argentiferous galena occurs only in very small quantity; it being almost absent in the southern Nandgaon hill.

The mineral fluorspar occurs in a pegmatite, which is intrusive into the granite and which runs in a dyke-like fashion practically in a north-south direction. It has a maximum width of about 64 feet and in places inclusions of the granite are enclosed in the pegmatite.

Khairagarh State.—The northern hill, as already noted, lies in the jurisdiction of the Khairagarh State and was being worked at the time of the first author's visit in November 1941. The overburden had been removed and fluorspar was being extracted from the central portion of the pegmatite. It has an average fluorspar content of about 22 per cent., a little more than that of the Nandgaon hill and the workable length is only about 400 feet from the road. The width is about the same as in the Nandgaon hill.

Nandgaon State.—The southern hill, across the road lies in the Nandgaon State. The dyke, in which fluorspar occurs, is about 30 feet in width on the average which in places dwindles down to 12-15 feet. The pegmatite appears to have almost vertical walls on either side. Towards the northern end, the dyke is more quartz-bearing, but it is also rich in fluorspar. Towards the southern end it assumes more felspathic character which has little fluorspar.

Mode of Occurrence of Fluorspar.—Fluorspar occurs in veins, the maximum thickness observed being about five inches. In some cases lenses of the country-rock also occur in these veins. Fine stringers are also commonly observed. In one place these veins were obsrved in coarse granite with pink felspar. Fluorspar and quartz are the main minerals forming these veins. It may be noted that blocks of what appeared like breccia were also observed. This breccia is apparently fault breccia and it is along this fault that the fluorite-bearing pegmatite intruded itself. Some of the blocks have a cavernous appearance filled subsequently with fluorspar, quartz and occasionally argentiferous galena. Sometimes fluorspar is deposited evidently in crevices in the rock.

The rock is highly crushed and is traversed by joint cracks running in several directions. Some of these cracks are hardly one-eighth of an inch apart and in these cracks fluorspar is deposited. Minute specks of green malachite are also observed.

Fluorspar, mostly mauve in colour, also occurs in irregular lanticles or patches. Those measuring four inches by two inches are not uncommon mut occasionally those having dimensions of two feet by three inches are also observed. Towards the crest of the hill the rock is richer in fluorspar than on the flanks. This mineral is also found associated with siliceous cavernous gangue, *e.g.*, near about 300 feet, from the main road, in the Khairagarh hill.

Physical Characters of Fluorspar.—The form is usually massive and compact. The colour is variable. It is whitish, greenish, bluish, violet-blue, pinkish and dark purple in colour almost approaching black. The streak is white. The lustre is vitreous. One set of cleavage is perfect. The fracture is splintery, subconchoidal. Hardness is 4. The specific gravity, as determined by Jolly's balance, is 3·0.

Microscopic Characters of Fluorspar.—The fluorspar occurs in granular form and also as metacrysts which show subhedral forms. One set of cleavage is perfect while the other is imperfect. It is observed to be intergrown with quartz and felspar which is clouded. In thin sections it is colourless but sometimes pinkish, purplish or bluish shades are to be observed. The mineral is isotropic. Some galena occurs in association. A little axinite and a few specks of chalcopyrite also occur.

Chemical Composition.—The following two chemical analyses of almost average specimens of the fluorspar rock were done by Mr. I. C. Pandey.

	I	II
SiO_2 ..	19·56	10·12
R_2O_3 ..	8·32	9·12
$CaCO_3$ ..	2·105	5·10
CaF_2 ..	68·52	72·15
H_2O+ .	0·32	1·32
H_2O-		
	99·825	97·81*

* PbO is present in small quantity.

I and II.—These almost average specimens are from the Khairagarh hill, where fluorspar was being extracted in November 1941.

The analyses show that the percentage of silica, which is in the form of quartz, varies from 10·12 to 19·56 while CaF_2 is in the neighbourhood of about 70 per cent. $CaCO_3$ varies from 3·105 to 5·10 per cent.

Working of the Deposit.—It appears that Messrs. Tata Iron and Steel Co. have carried on considerable prospecting in these hills. Towards the end of 1941, they had applied both to Nandgaon and Khairagarh States for mining leases, which were likely to be granted shortly. The Tatas were quarrying the rock with manual labour and they hoped to raise about 2,000 tons of fluorspar *per annum* with about 100 workmen. This fluorspar will be utilized in the manufacture of steel. In November 1941, experiments on hand-sampling, handdressing, etc., were being carried on. After quarrying, the rock is hammered into small pieces and those of fluorspar are separated by hand-picking from the gangue. Several stacks of fluorspar were found lying near the hill.

Origin of Fluorspar and History of Igneous Activity.—The history of igneous activity of this deposit may be briefly described as follows:—

(1) First, there was the intrusion of the main mass of the granite.

(2) In the granite there was the intrusion of the felspathic pegmatitic dyke. It has almost vertical walls and stands out very clearly from the surrounding decomposed granite.

(3) The pegmatitic phase was followed by the pneumatolytic phase when the vapours of fluorine, silica, etc., were responsible for the deposition of secondary clear quartz, fluorite, etc. It was usually observed that clear quartz and fluorspar generally occur together, shewing that vapours of fluorinee and SiO_2 acted together. When the dyke is entirely felspathic, it is almost surely devoid of fluorspar. In the siliceous or quartz-bearing rock, fluorspar is more likely to occur.

(4) Finally came the hydrothermal phase which was responsible for the dissolution of the felspathic material and the deposition of whitish chalcedonic or yellowish jaspery silica instead. It was observed that fluorite in this material was conspicuous by its absence. It appears that this form of silica was definitely deposited by the hydrothermal phase and by that time the vapours of fluorine, etc., belonging to the pneumatolytic phase, had ceased activity. Honey-combed cavernous structure is observed in places where quartz of the granite is still intact but by the dssolution of

the felspar, the cavernous structure has developed. These etched out spaces were subsequently filled with the white or yellowish silica.

Department of Geology,
Lucknow University, H. L. CHHIBBER.
November 16, 1944. I. C. PANDEY.

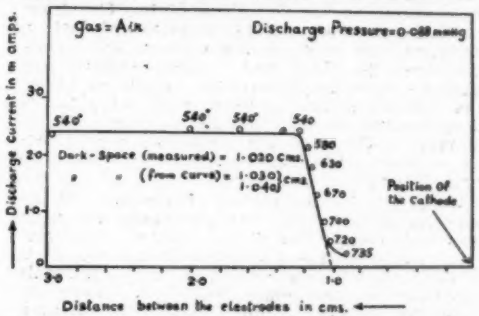
1. *Rcds. G.S.I.*, 1868, **1**, 37. 2. —, 1870, **3**, 44. 3. —, 1939, **74**, 406.

ON THE CATHODE DARK-SPACE OF A GLOW DISCHARGE IN GASES AT LOW PRESSURES

A NUMBER of experimenters [1,2,3] have studied the characteristics of the cathode Dark-Space and they all agree that this is the most active region of a glow discharge. The views held by different investigators on the mechanism of the flow of current across the Dark-Space are, however, very divergent. Thomson[4] believes that the ionisation in the space is caused by electrons which themselves are emitted from the cathode surface by the impact of the positive ions so produced. This theory finds a good support from the experiments of Oliphant[5] on the secondary electron emission from metals by positive ions. The entire supply of the ions to the cathode is, according to them, from the Dark-Space itself and very few of them flow into it from the negative glow and particularly so when the discharge is normal. Moreover, they consider it probable that on account of their high density in the Dark-Space some of the ions flow back into the negative glow. Loeb[6] takes the reverse process to be more probable. Ryde[7] and Compton and Morse[8] also hold that it is the negative glow which acts as a source of the positive ions. They further assume that this section of the discharge behaves like an emitter of the ions and the cathode as a collector of them, the relation connecting the cathode fall, the Dark-Space length and the discharge current being of the same form as the Langmuir's Space-Charge Law which is true for electronic emission from a hot metal in a high vacuum. There is, however, no direct experimental evidence in favour of any of the above assumptions.

We have carried out experiments with two plane parallel electrodes in a discharge tube, the anode being moveable. It is observed that as the anode is brought closer to the cathode there is no variation in the discharge current or the voltage till the former reaches a point in the negative glow a few mm. away from the boundary of the cathode Dark-Space. If the anode is pushed further towards the cathode the current regularly falls but the voltage required to maintain the current rises continuously. The fall in the current is linear with the displacement of the anode till it reaches a point near the edge of the Dark-Space. Beyond that the current diminishes much more gradually.

A large number of curves connecting the discharge current and the distance between the electrodes have been obtained. The curve in the figure typifies the results in Air and Oxygen. The voltage required to maintain the



discharge current at varying distances between the electrodes is given along the curve at each step. If the straight falling part of the curve is produced to cut the distance axis the point of intersection of the two lies away from the cathode equal to the width of the cathode Dark-Space which was measured usually with the help of a cathetometer. This applies practically to all the curves.

The experiments have been carried out in air over a pressure range, 0·043-0·142 mm. Hg, voltage range, 350-950 volts and current range, 1·2-4·0 m.amps.; corresponding values for oxygen are 0·112-0·165 mm. Hg, 400-520 volts and 1·8-3·2 m.amps.

We have come to the following conclusion from these experiments:—

1. The positive ions reaching the cathode do not all come from the Dark-Space but a considerable number of them flows into the Dark-Space from the negative glow under all conditions of the discharge studied.

2. The discharge current is carried across the common boundary of the Dark-Space and the negative glow both by the cathode rays and the positive ions travelling in opposite directions.

3. The length of the negative glow which acts as a source of the positive ions to the Dark-Space depends upon the discharge voltage and pressure.

Details of the experiments will be published elsewhere.

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S. H. ZUBERI.

Physics Department,
Muslim University,
Aligarh,
January 2, 1945.

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GROWTH OF THE SHOOT IN *ASPARAGUS RACEMOSUS* WILLD

LINEAR growth of the shoot can be observed in a few plants without the aid of an Auxanometer or a horizontal microscope. In the Cucurbitaceæ the rate of growth is rapid but the elongation of the stem is accompanied by the growth and the increase in size of the leaves, axillary shoots and flowers. Kraus[1] and Smith[6] have recorded daily increase in growth in *Bambusa* which is quite rapid. The total elongation in *Bambusa*, however, is the result of the activity of several growth zones and a younger internode might start growing after the older has entirely ceased to grow. There is thus a periodic rise and fall in the net growth-increase or elongation.

In *Asparagus racemosus* Willd., the shoot in the beginning elongates at a very rapid rate and the growth is linear till the axillary shoots appear, as the leaves are reduced to scales. The growth of axillary shoots is delayed till the main shoot has attained some length. The axillary shoots also grow very rapidly but then the main shoot grows very slowly. Till the axillary shoots begin to grow rapidly, the growth of the main shoot is appreciably great and can be directly measured by means of a scale without the help of an Auxanometer or a horizontal microscope. The writer[2, 3] has already recorded the 12-hourly rate of growth of a number of shoots in *Asparagus racemosus* and *Asparagus sprengrii*.

It was also observed that the rate of growth for the day is 25 per cent. higher than at night. Periodicity in this matter—higher rate of growth during day than at night—was observed in the case of shoots of both the species. Further observations were made to elucidate this point. A number of shoots are given out by *Asparagus* during spring. They grow rapidly till they attain a definite height, without producing axillarly shoots. The height attained by different shoots of the same plant was 114·5 cms., 116·5 cms., 127·0 cms., and 78 cms. This plant was four years old and was growing in field-conditions in a 12-inch flower-pot. Older plants in the ground grow more than 350 cms. before the axillary shoots are formed.

The growth-rate is slow in the beginning, then it becomes rapid, attains maximum rate after which it gradually falls off. The figures in the second row begin with slow rate of growth—·8 cm., ·4 cm. for 12 hours and later on, growth was uniformly higher for some days having reached a maximum of 6·7 cms. for 12 hours after which it fell off quickly when the axillary shoots appeared. This is also true in the other three cases.

The record of the 12-hourly rate of increase in centimeters of the shoot of *Aspearagus racemosus* is noted in Table I.

The maximum increase in the four cases was:—

	Per 12 hours	Per minute
I	8·5 cms.	·12mm.
II	6·7 cms.	·09mm.
III	9·9 cms.	·13mm.
IV	8·9 cms.	·12mm.

Kraus[1] noted an increase of 0·4 mm. per minute in the stem of *Bambusa* and Smith, A.M.[6] observed elongation at a rate of nearly 0·4 mm. per minute. These varying results in *Bambusa* may be due to various causes.

TABLE I

(Observations were made at 8 a.m. and 8 p.m. each day) D = Day, N = Night

	16th April		17th April		18th April		19th April		20th April		21st April		22nd April		23rd April		24th April		25th April		26th April		27th April	
Shoot	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
I	6·6	6·4	7·0	5·5	6·0	4·0	8·5	5·0	7·0	5·5	5·0	3·5	4·8	2·7										
II	·8	·4	3·0	3·2	5·4	3·5	4·9	6·0	6·5	6·5	6·2	5·1	6·7	6·0	5·5	1·0	0·5	0·5						
III					2·0	2·5	5·4	5·0	6·0	7·5	5·5	8·0	6·7	8·5	9·1	6·5	8·7	5·0	6·5		13 0	4·5	4·5	
IV													4·5	7·0	7·5	6·0	7·0	4·1	7·9	8·9	1·2	6·4		
	Shoot was removed				Rapid						Maximum												Slow	

TABLE II

	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D
I	6·4	7·0	5·5	6·0	4·0	8·5	5·0	7·0	5·5	5·0	3·5	4·8	2·7							
II		3·0	3·2	5·4	3·5	4·9	6·0	6·5	6·5	6·2	5·1	6·7								
III					2·5	5·4	5·0	6·0	7·5	5·5	8·0	6·7	8·5	9·1	6·5	8·7	5·0	6·5		
IV													7·0	7·5	6·0	7 0	4·1	7·9		

D—Day. N—Night.

Moller, A.,[5] observed an increase of 5 mm. per minute in the fruitification of *Dictyophora*.

There is periodicity in the day and night rates of elongation. Generally the increase in the day time is higher than in the night and the periodicity is almost regular except in shoots I and III on 21st April. The suggestive figures of elongation are given in Table II.

Thus elongation during the day is generally higher than in the night. This has been observed earlier by the writer[3] and further observations were made to elucidate this point. This may be due to the fact that the plant is adding new material continuously during the day time as suggested by Blackman,[4] or there is more rapid translocations of the food materials from the tubers during the day than at night.

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Jodhpur, SHANTI SARUP.
January 18, 1945.

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ELECTRIC POTENTIAL OF THE EARTH'S SURFACE

IT has been commonly assumed that the electric potential of the earth's surface is a fixed quantity, and that its magnitude is zero. It should be worthwhile, however, to see whether this concept is correct from the standpoint of modern theory.

According to geophysics the central portion of the earth's interior is a spherical core of a hot, ionised, liquid metallic mass of radius 3,500 km.[1] rotating round the terrestrial magnetic axis,[2] and that the earth's magnetism requires that it be negatively charged. It has also been computed that there emerges at the surface of this spherical core a strong electric field varying between 10^6 volts per cm.[3] and 10^8 volts per cm.[4] Around this hot core is the comparatively cold earth's crust, made up of crystalline rock, which is 2,900 km. thick, and which extends to the earth's surface.

During the process of cooling through the ages, there is a considerable thermo-electric current passing between the surface of the core and the underside of the crust.[5] There is also a negative charge on the earth's surface which is indicated by the presence of the atmospheric electric field which at sea level varies from 100 to 500 volts per metre, and approaches a zero value at the uppermost layers of the atmosphere, that is to say, it varies from one to five times its basic value. There is also considerable flow of an air-earth electric current from the upper air to the earth's surface. Around the earth, further, there is the outer shell of the upper atmosphere, which is known to bear a positive charge, and the whole system is enveloped in the corpuscular radiation which the sun is continuously sending out into the space surrounding it.

Since we know by induction that there must be a positive "surface" charge on the underside of the earth's crust; that there is a negative surface charge on the earth's surface; that thermo-electrons continually enter the underside of the crust; that air-earth current electrons leave at the earth's surface; that the strength of the core's field is of the order of 10^6 volts per cm. and that the electric fiel which emerges at the earth's surface is merely a few volts per cm., we must infer that there exists an exceedingly steep difference of potential between the under and the upper surfaces of the crust, and that the electric potential of the earth's surface with respect to the core must thus be of a very high order of magnitude, and not zero as has been commonly assumed.

We further know that corpuscular radiation from the sun so affects the positively charged shell of the outermost upper atmosphere and consequently, the earth's total charge, that the terrestrial electric field has been found to vary in direct proportion.[6]

We are unfortunately not in possession of adequate data on the exact nature of variation of the terrestrial electric field within the earth's crust, but it must obviously satisfy the relationship $y = f(Q, x)$ in which y is the field strength and Q, the earth's charge, and that the electric potential P, of the earth's surface must be given by $P = 2900 \text{ km.} \int f(Q)\,dx$, x being height of a point on the earth's surface measured from core's surface. Since, however, Q is a quantity which we found, varied directly as the terrestrial electric field, which we know changes from time to time, it is obvious that the electric potential of the earth's surface with respect to the core is not a fixed quantity as is commonly assumed but that it varies over a wide range of values, and that it does so in direct proportion to the magnitude of the field as registered by an electrograph at the earth's surface at a given instant of time.

Colaba Observatory,
Bombay, ALFRED B. ARLICK.
January 25, 1945.

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AN ELECTROLYTE-FREE MEDIUM FOR THE FROG HEART AND GRADED RESPONSES OF THE HEART MUSCLE

RINGER has shown that for the proper functioning of the heart, the external medium must contain suitable amounts of sodium, calcium and potassium. It is generally believed that for the contraction of all kinds of muscle, these ions are necessary. Singh (1944) has, however, shown that the frog stomach contracts spontaneously and remains irritable to electric current for about 4-6 hours in a half tonic solution of sucrose.

It has been found that the electrolyte-free medium for the frog stomach is equally good for the frog hearts used in this series of investigations. When perfused with half tonic sucrose solution, the frog heart presents the same series of phenomena as the frog stomach. At first there is a contracture followed by depression of excitability. The heart then recovers and continues to beat from half an hour to two hours; the rhythm and relaxation are, however, slow (Fig. 1). For some hearts,

FIG. 1. A. Beating of the frog heart in Ringer. B. Beating of the same heart in isotonic solution of sucrose, after 25 minutes immersion. The heart may continue beating slowly for about two hours in the absence of electrolytes. It may remain irritable to induction shocks for another two hours.

C. Frog heart. Graded responses. Contractions No. 1 by 1·5 v for 5 sec. (D.C.).

Contraction No. 2 by 3 v D.C.
do 3 do 4·5 v D.C.
do 4 do 6·0 do
do 5 do 7·5 do
do 6 do 9 v do

In contraction Nos. 1, 2 the heart has only responded to make. In contractions No. 3, 4, 5, the heart has responded by rhythmic contractions. In contraction No. 6, the heart has responded by tetanus.

an isotonic solution of sucrose was found to be better than half tonic sucrose, but if the heart had come to a standstill in the isotonic sucrose, it was revived by the half tonic sucrose solution. After the heart had stopped beating in the electrolyte-free medium, it remained irritable to induction shocks for a considerable time (one to two hours). It is thus remarkable that the heart should contract in the absence of all electrolytes; this shows that excitation in the heart muscle is produced by ions within the muscle fibres, and that the function of ions in the Ringer solution is to mutually antagonise one another.

Another remarkable phenomenon presented by these hearts was, that they behaved like plain muscle, in responding by contracture to acetylcholine and excess of potassium. As plain muscle does not obey the "All and None" law, it is to be expected that the same law would not hold good for these hearts. This was actually found to be the case. When stimulated with direct current by voltages ranging from 1·5 to 20, the responses were graded [Fig. 1 (c)]. The contraction produced by break induction shock was bigger than that produced by make shock.

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Department of Physiology,
Dow Medical College,
Hyderabad (Sind),
February 19, 1945.

1. Singh, I., *Curr. Sci.*, Oct. 1944,

CHROMOSOME NUMBER OF *SESAMUM LACINIATUM*, KLEIN.

ONLY three species of *Sesamum* are reported in the Indian flora (Hooker). Of these, *Sesamum orientale* Linn. (=*Sesamum indicum* D.C.) is the commercial til. Both *Sesamum prostratum* Ret. and *Sesamum laciniatum* Klein. are prostrate, perennial weeds. They closely resemble one another but for the fact of the leaves of *Sasamum laciniatum* being deeply pinnatifid. The capsules of *Sesamum laciniatum* are smaller than those of *S. prostratum*. The chromosome number of *Sesamum orientale* has already been determined to be $2n = 26$ in this laboratory (Sreenivasan, 1942). Cytogenetical work in this genus has been in progress here for some years now. Interspecific hybridisation between *Sesamum orientale* and *Sesamum prostratum* has been effected and the sterile hybrid has been made fertile by the artificial induction of amphidiploidy. Cytological and cytogenetical details connected with this work will appear elsewhere as a paper. The fertile amphidiploid is being grown through several generations and its seeds compared with those of *Sesamum orientale* in all respects, quality, quantity, oil yield, etc. It has been found that while *Sesamum orientale* is a seasonal herb, this fertile amphidiploid is perennial, flowering and fruiting throughout the year. In connection with these studies, the chromosome number of *Sesamum prostratum* ($2n = 32$, $n = 16$) both somatic and meiotic, has been determined in this laboratory (Krishnamurthy). The chromosome number of *Sesamum radiatum*, an Argentine species, was reported some years ago to be $2n = 64$ (John and Narasingha Rao). So far as we are aware, the chromosome number of the other Indian species of *Sesamum*, namely, *Sesamum laciniatum* has not been recorded. Specimens of this species were collected from several parts of India and are being grown in the University Botanical Gardens. We are carrying on hybridisation work between this

species and *Sesamum orientale* on the one hand and between this species and *Sesamum prostratum* on the other. Full cytological and cytogenetical details relating to this investigation will be published in due course. In the meantime the chromosome number of *Sesamum laciniatum* has been determined to be $2n = 28$ (Fig. 1). Prochromosomes which were a com-

mon feature in the other species of *Sesamum* are found to be very prominent in this species also. A full account of the prochromosome-chromosome relationship, based on observations on these species, and their correlation to the nucleolar cycle, will form the subject of a separate paper.

Botanical Laboratory,
Annamalai University, T. S. Raghavan.
Annamalainagar, K. V. Krishnamurthy.
March 6, 1945.

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ON THE OCCURRENCE AND DISTRIBUTION OF *POTHOS SCANDENS* LINN., VAR. *HELFERIANUS*, ENGL. IN BENGAL

In the province of Bengal *Pothos scandens* Linn., an epiphytic climber is found growing upon several kinds of plants. Prain[3] in 1903 reported that *Pothos scandens* Linn. occurs in North Bengal and Chittagong but there is no mention of any other variety or species of the same genus from any other part of the province, though other species were reported by Hooker[2] in 1893 from the whole of India. The latter author also corroborated Prain and stated that the only species of *Pothos*, found in Bengal, is *Pothos scandens* Linn. Prain[4] further in 1905 in his survey of the flora of 24-Pergannhas, Hoogly and Howrah districts did not mention the occurrence of any species or variety of *Pothos*.

Pothos angustifolius Hook. f. (non-Presl.), as recorded by Hooker,[2] is according to the latest nomenclature is reduced to a variety of *Pothos scandens* Linn. by Engler[1] and is named *Pothos scandens* Linn., var. *Helferianus* Engl.

In the latter part of December 1944, and in the beginning of March 1945, the present writer came across in course of excursions in the suburban villages of the city of Dacca (Bengal) and collected *Pothos scandens* Linn. var. *Helferianus* Engl., and found it climbing on the bases of several trees in shady places. Since the first collection, Mr. Murari Prosad Guha, Lecturer in Botany of this College, collected this plant from Jamuria, Tangail (Dist. Mymensingh) in the latter part of January 1945 for the writer's anatomical studies. He also brought the flowering specimens of *Pothos scandens* Linn. Both Mr. Guha and the writer could not procure any flowering specimens of this variety during this period.

Dr. S. K. Mukherjee, Curator of the Herbarium, Royal Botanic Gardens, Sibpore, Calcutta, very kindly informs the writer that the *Helferianus* variety of *Pothos scandens* was collected from Agartalla (Dist. Tipperah) and the neighbourhood of Calcutta. But it is likely that the plant was collected after Prain[3] had recorded his observations in his careful survey.

Rendle[5] wrote that the genus *Pothos* with its fifty species is chiefly Malayan. Hooker[2] collected *Pothos angustifolius* Hook. f. (non-Presl.) (= *Pothos scandens* Linn. var. *Helferianus* Engl.) from Tennasserim, Burma—a place 950 miles away (coast to coast) from the border of the province of Bengal and where the Malayan vegetation is dominant. From the nature of distribution it becomes evident that the plant had migrated from Tennesserim (Burma) and entered into the province *via* Chittagong and gradually spread over other districts, *e.g.*, Tipperah, Mymensingh, Dacca, etc., in course of about fifty years. Afterwards it has become naturalised and formed a unit of the local vegetation. The writer also surmises that this plant was brought and introduced as a garden climber in the neighbourhood of Calcutta for its nice small unifoliate leaves and from there it had become an escape and spread over that locality after Prain's[3] survey.

Botany Department,
J. I. Colloge, Dacca, R. M. Datta.
March 7, 1945.

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HAIRINESS OF COTTON LEAVES AND ANTI-JASSID RESISTANCE

The evolution of resistant varieties has been regarded as the most effective line of defence against the jassid, *Empoasca devastans* Dist., which is a major pest of cotton in the Punjab, Sind and Madras. It has been generally believed that varieties with hairy leaves are more resistant to jassid attack than those not possessing this character. For this reason cotton breeders have bred for hairiness in evolv-

ing jassid-resistant types. A note of warning was, however, sounded against placing exclusive and excessive reliance on leaf hairiness (Afzal Husain and Lal, 1940). It was suggested that hairiness might be a mere indicator rather than the actual factor of resistance, and that it would be by discovering the real and true cause of resistance; that the work of breeding resistant varieties could proceed on scientific basis.

Recently Afzal and Abbas (1943) have put forward the view that, although hairiness by itself does not confer any resistance on cotton plants against jassids, it is well enough associated with 'resistance' and, being easily recognisable and workable, is a safe character for the breeder to utilise. They, therefore, recommend breeders to select or evolve only very hairy varieties for areas liable to severe jassid attacks. The questions that arise are: Would scientific breeders be justified in accepting the position that they breed for a character, which in itself is of a doubtful value but serves only as an indicator of resistance? And, secondly, to what extent would such an indicator keep true to its role under varying conditions of climate and culture and in the permutations and combinations of genes in breeding?

It was shown by us (Afzal Husain and Lal, 1940) that the resistance of hairy varieties was due not to the inability of the jassids to feed on the hairy types, but to their mability to oviposit on them and, therefore, the jassid-resistant character should be sought for in the leaf veins —the seat of oviposition. Afzal and Abbas (*op. cit.*) state that Verma and Afzal (1940) tentatively conclude that the 'toughness of the cuticle of the leaf vein, which prevented the entry of the ovipositor, was the primary character which made the plant resistant,' but consider that toughness cannot be of much practical help to breeders, who must have a quick and ready means of identifying resistant plants and the determination of the relative toughness of the leaf veins involves laborious and delicate work. Is such an attitude justifiable? Should not greater reliance be placed on future research to solve the question of measuring the toughness of leaf veins quickly and simply if this proves to be chief factor imparting resistance?

If hairiness is closely linked with the jassid-resistant character and toughness of leaf vein is that character, then a very hairy leaf should also have a tough cuticle of its leaf veins. It should be valuable to determine this correlation. Unfortunately Afzal and Abbas carried out no experiments to throw light on this important point. Instead, they felt satisfied by the correlation between hairiness and resistance, observed in pure varieties as well as some hybrid progenies. On this basis they conclude that we were misled into casting doubt on the value of hairiness as an indicator of resistance, because he worked with pure varieties only, and, secondly, that errors (?) in our classification of varieties, in respect of jassid resistance, vitiate our findings. The suggestion, therefore, is that hairiness and resistance may be independent characters in pure varieties but not under hybridisation. The only evidence for this generalisation is the association of hairiness and resistance observed, in a small number of plants, of only one hybrid progeny; the rest of their observations, as ours, were made on pure varieties. Afzal and Abbas have neither given any genetic explanation as to why and how hairiness and resistance must be invariably associated together in breeding, nor have they tested a sufficiently large number of hybrid progenies, under different climatic and cultural conditions, to warrant their conclusions. In the absence of such explanations or tests or both, of what value is their recommendation to choose only hairy varieties for jassid resistance? We maintain, without fear of contradiction, that the degree of hairiness varies with the age of the plant and of the leaves as well as under different climatic conditions and cultural operations. If such be the case, would not the same variety be more hairy in one area and less in another, without, in any way, altering its resistance to jassid attack?

Regarding our alleged error in classifying 43 F as susceptible, which Afzal and Abbas observed to be resistant, the classification was not due to error but to the erratic behaviour of the variety itself, as was pointed out by Lal (1937). The general statement by Afzal and Abbas (*op. cit.*) that 'in all previous literature on hariness in relation to jassid, no mention has anywhere been made of the position of the leaf on the plant' is also not justified, since exactly the same and other precautions were taken by us (Lal, *op. cit.*) in choosing leaves for the measurement of their hairiness, as indicated by the authors.

K. B. LAL.
M. AFZAL HUSAIN.

April 9, 1945.

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ON THE FORMATION OF AUXOSPORES IN *BACTERIASTRUM*

AUXOSPORE-FORMATION is known only in a few species among the Centrales. Any new case of auxospore-formation in this group is always interesting. This process does not appear to have been recorded so far in the genus *Bacteriastrum*. The author, while working on the marine plankton Diatoms of the Madras Coast, observed the formation of auxospores in *Bacteriastrum varians* Lauder. A brief account of the process is given here.

During auxospore-formation, the valves of the mother-cell move apart and the cell protoplast emerges out surrounded by a delicate membrane, the perizonium [Figs. 1 (*a*) and

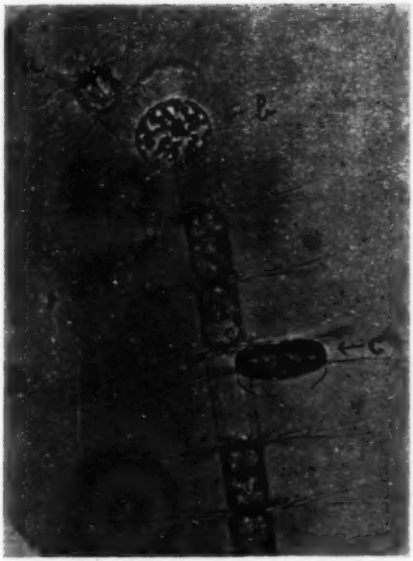


FIG. 1

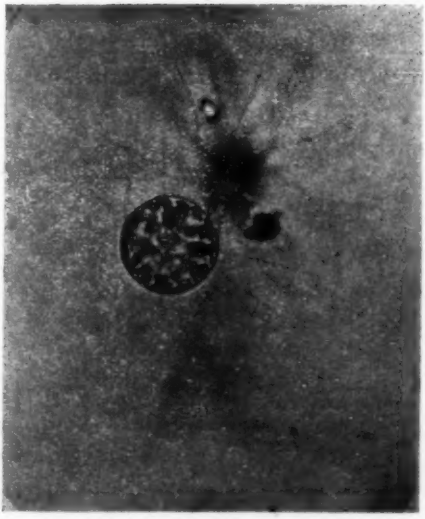
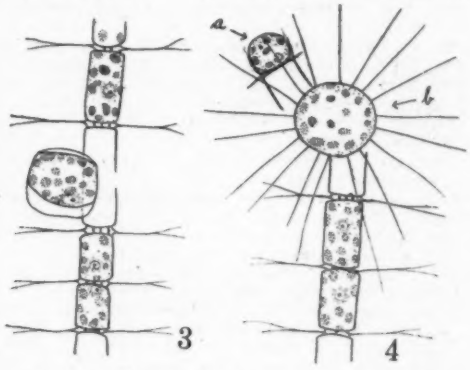


FIG. 2

4 (*a*)]. The protoplast after coming out of the valves (auxospore), gradually grows until it reaches a very large size. The contents of this auxospore then contract from one side of the perizonium first and secrete a valve. The contents then contract from the opposite side also and secrete the second valve (Fig. 3).



FIGS. 1–4. *Bacteriastrum varians* Lauder.

Fig. 1. Photomicrograph of a chain of cells showing auxospore-formation ; *a*, the protoplast of a cell which has emerged out of the valves ; *b*, new cell formed by auxospore formation seen in valve view ; *c*., another new cell formed by auxospore-formati on seen in girdle view. Note the ruptured perizonium. × 350. Fig. 2. Photomicrograph of a new cell formed by auxospore-formation seen in valve view. × 350. Fig. 3. Auxospore-formation in one of the cells of a chain. Note new valves being secreted inside the perizonium. × 350. Fig. 4. Same as Fig. 1. Only a portion (*a* and *b*) of Fig. 1. shown. × 350. All from living specimens.

As the valves are secreted the characteristic spines or setæ of the Diatom are also developed [Fig. 1 (*b*) and 4 (*b*)]. The setæ develop in the same manner as was observed by Iyengar and Subrahmanyan (1944, p. 118) during the vegetative division of the same Diatom. The perizonium becomes ruptured and the new cell becomes free [Fig. 1 (*c*)]. The new cells have a diameter about two and a half times that of the mother-cell of the auxospore (Fig. 2). Vegetative divisions then take place in the new cell and soon a chain of cells is formed.

Auxospore-formation takes place in the chains of cells which through successive vegetative divisions have become very narrow in diameter. Only one auxospore is formed in each cell, but auxospore-formation may take place simultaneously in several cells of the same chain.

The author wishes to express his indebtedness to Prof. M. O. P. Iyengar for his kind help and guidance during this investigation.

University Botany Lab.,
Madras, R. SUBRAHMANYAN.
April 24, 1945.

1. Iyengar, M. O. P., and Subrahmanyan, R., "On the Structure and Development of the Spines or Setæ of some Centric Diatoms," *Proc. Nat. Acad. Sci., India*, 1944, **14**, Pt. 3, 114–124.

TWO NEW RECORDS OF THE SPECIES OF THE GENUS *TRICHURIS* FROM INDIAN RUMINANTS

In the paper are recorded, *Trichuris parvispiculum* from goats and sheep and *Trichuris discolor* from cattle and buffaloes. *T. parvispiculum* is previously known from goats in South Africa Ortlepp (1937) while *T. discolor* was originally described by V. Linstow (1906) from Ceylon. *T. parvispiculum* is a very common parasite of sheep and goats in the Punjab and United Provinces and was collected from Sialkot, Lahore, Multan, Delhi, Mukteswar-Kumaon and Izatnagar. *T. discolor* is on the hand rare and has been collected only from five cases out of fifty so far examined. Those were collected twice from Mukteswar, once from Izatnagar and twice from Sialkot. Examination of fæces of calves at Izatnagar showed that calves of about 1½ years of age always harboured trichurids. It has previously been reported by the author (paper in press) that *Trichuris globuloso* is a very common parasite of sheep and goats and occurs along with *T. parvispiculum*. The cattle slaughtered in localities where this parasite occurs, do not harbour *T. globulosa* though it has been reported from these animals from other countries.

Description of *T. parvispiculum* is not given in the paper as the material tallies in all essentials with that of the original author. A character not mentioned by him is that there are

FIG. 1. *T. discolor*; Vagina

cuticular vesicles on the anterior part of the species. Presence of cuticular vesicles has been mentioned by Hall (1910), Solomon (1932) and Baylis (1935) in the species *T. leporis*, *T. spiricollis* and *T. mettami* respectively.

Host: *Capra hircus* and *Ovis aries*.
Location: Cæcum.
Locality: Indicated in the text.

It is not the intention of the author to dwell of characters already described by V. Linstow and hence only characters not previously described and considered useful in the proper identification of the species are included. The description is based on thirty individuals.

Male: Internal genitalia. Vas deferens measures from 2·4-3·15 mm. and ejaculatory duct 8·6-10·2 mm. long. The muscular constriction which joins the two parts is about 0·27 × 0·18 mm. Cloaca varies 1·55-1·7 mm. in length with the spicular tube joining it 0·55-0·85 from the posterior end. The ejaculatory duct pursues a somewhat wavy course for some distance from its start and is approximately about three times the size of vas deferens and seven times the size of cloaca. Testis starts in the region of cloaca, is straight in about one-third of the ejaculatory region, becoming moderately convoluted thereafter while in the region of vas deferens it is beaded.

There are vesicular swellings on the anterior end and cuticular vesicles and plaques at some distance from the anterior end. There is a conical papilla on either side of the posterior end.

Female: Vagina after about two proximal curves is straight for some distance and is again followed by a few curves before joining the uterus. The diameter of the straight middle part is even throughout, is less than that of the proximal curves and is at the same time less muscular.

Host: *Bos indicus* and *Bos bubalis*.
Location: Cæcum.
Locality: Mukteswar-Kumaon, Izatnagar, U.P., Sialkot (Punjab).

Military Dehydrated Meat Factory,
Agra, M. M. SARWAR.
May 7, 1945.

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STUDIES ON THE CATALYTIC FORMATION OF DI-OLEFINS FROM MONO-OLEFINS

(a) *Chemical Equilibrium in Butadiene-1, 3 Formation from Butene-1 at Low Pressures*

In view of the difficulties involved in the determination of chemical equilibrium in the dehydrogenation of butene-1 to butadiene-1, 3, at atmospheric pressure, even in the presence of a highly active catalyst such as Cr_2O_3-Al_2O_3, an apparatus has been specially devised to study the reaction at the lower pressures of 10-50 mm. of mercury and in the temperature range of 360-540° C. The reaction has been studied in detail over the following three catalysts:

(1) Cr_2O_3-Al_2O_3 (5 per cent.); (2) Cr_2O_3-Al_2O_3 (5 per cent.)-V_2O_5 (2·5 per cent.)-Mo_2O_3 (2·5 per cent.); (3) Cr_2O_3-Al_2O_3 (5 per cent.)-Cu (10 per cent.), of which the catalyst No. (3) promoted by copper has been found most efficient. The equilibrium constant of the reaction has been calculated from the equation,

$$K_p = \frac{Px^2}{(1-x^2)}$$

where x is the degree of dissociation of butene-1 and P is the total pressure in atmosphere. From the value of K_p, free energy of the reaction has been evaluated by using the relation, $\Delta F_T = -RT \ln K_p$ The following

values of K_p and ΔF_T for reactions at five different temperatures have been obtained (Table I).

TABLE I

Temperature °C.	K_p	ΔF_T (Calories)
370	0·000244	10,620
410	0·000823	9.642
440	0·002080	8,748
470	0·004703	7,911
500	0·008668	7,294

From the above values of K_p, the following mean value of the heat of reaction (temperature range 370-500° C.) is obtained:

$$\Delta H_T = 28{,}600 \text{ calories.}$$

The free energy as a linear function of temperature is expressed by the equation: $\Delta F_T = 29{,}352 - 28{\cdot}58\,T$. The temperature of neutral equilibrium is: $T_0 = 744°$ C.

TABLE II

Temperature °C.	K_p	ΔF_T (Calories)
330	0·000,261	9,880
370	0·001,020	8,800
410	0·003,752	7,580
450	0·011,100	6 465

(c) Heat of Reaction, Free Energy of Reaction and Entropy in the Dehydrogenation Equilibrium of Paraffin-Olefin Isomers-Diolefin of the Isopentane and n*-Butane Series*

Employing the results obtained from the study of dehydrogenation equilibrium of the two very important oleffins, butene-1 and 3-methyl-butene-1 to the corresponding diolefins, butadiene 1,3 and isoprene in conjunction with the accurate data on the heats of formation obtained by Rossini,[1] heats of hydrogenation obtained by Kistiakowsky,[2] entropy and free energy functions calculated by Pitzer[3] by statistical method and specific heat data given by Beeck[4] the various thermodynamic functions involved in the dehydrogenation equilibrium of Paraffin-Oleffinisomers-Diolefin of the *n*-Butane and Isopentane series have been calculated. A summary of the more important derivations are given in Table III.

TABLE III

Reactions	Equations for standard Free energies of the reactions	$\Delta H°_{298}$ cals	$\Delta F°_{298}$ cals.	$\Delta S°_{298}$ E.U.	$T°_0$C.
n-Butane⇌Butene-1 + H_2	$\Delta F_T = 28{,}252 + X^* + 12{\cdot}21T$	30,098	20,442	32·4	656
n-Butane⇌*cis* Butene-2 + H_2	$\Delta F_T = 26{,}481 + X + 14{\cdot}01T$	28,327	19,207	30·6	653
n-Butane⇌*trans* Butene-2 + H_2	$\Delta F_T = 25{,}531 + X + 14{\cdot}6T$	27,377	18,437	30·0	640
Butene-1⇌Butadiene-1 3 + H_2	$\Delta F_T = 25{,}496 + X + 20{\cdot}03T$	27,342	20,015	24·6	744
Cis Butene-2⇌Butadiene-1,3 + H_2	$\Delta F_T = 27{,}267 + X + 18{\cdot}25T$	29.113	21,255	26·5	
Trans Butene-2⇌Butadiene-1,3 + H_2	$\Delta F_T = 28{,}259 + X + 17{\cdot}5T$	30,105	22,025	27·1	
Isopentane⇌3-Methyl-Butene-1 + H_2	$\Delta F_T = 28{,}247 + X + 15{\cdot}12T$	30,093	21,303	29·5	743
Isopentane⇌2-Methyl-Butene-1 + H_2	$\Delta F_T = 26{,}401 + X + 15{\cdot}12T$	28,247	19,457	29·5	685
Isopentane⇌2-Methyl-Butene-2 + H_2	$\Delta F_T = 24{,}830 + X + 16{\cdot}91T$	26,676	18,422	27·7	690
3-Methyl-butene-1⇌Isoprene + H_2	$\Delta F_T = 23{,}884 + X + 19{\cdot}44T$	25,750	18,228	25·2	672
2-Methyl-butene-1⇌Isoprene + H_2	$\Delta F_T = 25{,}750 + X + 19{\cdot}37T$	27,596	20,074	25·2	
2-Methyl-butene-2⇌Isoprene + H_2	$\Delta F_T = 27{,}321 + X + 17{\cdot}53T$	29,167	21,095	27·1	

* $X = -6{\cdot}86T/nT + 0{\cdot}0023T^2 - 10^{-7}T^3$.

(b) Chemical Equilibrium in Isoprene Formation from 3-Methylbutene-1 at Low Pressures

Chemical equilibrium in the dehydrogenation of 3-methyl-butene-1 to Isoprene has been studied at pressures of 10 to 35 mm. of mercury and in the temperature range of 330-450°C., over Cr_2O_3-Al_2O_3-V_2O_3-Mo_2O_3 as catalyst. To maintain the activity of the catalyst steady, it was periodically activated by treatment with hydrogen at 550-575° C. From the values of K_p, the following thermodynamic characteristics of the reaction have been obtained (Table II).

The mean value of the heat of reaction: $\Delta H_T = 27{,}120$ calories. Free energy as a linear function of temperature: $\Delta F = 27{,}570 - 27{\cdot}19\,T$.

Temperature of neutral equilibrium:

$$T_0 = 671{\cdot}5° \text{ C.}$$

Dept. of General Chemistry,
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Bangalore, J. C. GHOSH.
May 23, 1945. A. N. ROY.

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REVIEWS

Radio Receivers and Transmitters. By S. W. Amos and F. W. Kellaway. (Chapman and Hall, Ltd., 11, Henrietta St., London), 1944. Pp. x + 281 with 150 figures and 8 plates. Price 21 *sh.* net.

There is certainly a real need for a competent book dealing specifically with the various aspects of the design, construction and operation of modern radio receivers and transmitters used for the different types of radio communication. But the volume under review is not, as its title would lead one to expect, such a book. In any case, this subject has developed so greatly that it would be impossible to deal with it satisfactorily within 300 pages, the size of the present book, which is essentially a text-book on the general principles of radio engineering. The title of the book is, therefore, not quite appropriate to its contents. As the authors say, it is not meant for the beginner, but for th esomewhat more advanced student.

The ground covered here is not greatly different from that of the usual text-books Starting with an introduction to the basic ideas and expressions, such as the nature of radio waves, amplitude and frequency modulation, etc., the authors go on to a discussion of the elementary electric circuits and their properties. In Chapter V, five pages out of the eighteen are devoted to radio wave propagation and the rest to receiving and transmitting aerials, mostly for short-wave working Vacuum tubes and their uses, audio and radio frequency amplifiers and their classification into A, B and C types are dealt with in chapters VI, VII and VIII. Chapters VIII and IX cover receivers for amplitude and frequency modulation. The last chapter is devoted to transmitters for telegraphy, amplitude and frequency modulation broadcasting and television. The appendices at the end of the book deal with some of the familiar expressions relating to radio circuits.

The arrangement of the various topics and their treatment leave something to be desired The discussion on vacuum tube theory is rather superficial and spread about. Microphones get about a page and that in the chapter on transmitters in between class B radio amplifiers and transmission lines. Quartz crystals cover about 2 pages. The explanations are in many cases not accurate. A few examples taken at random are the sections dealing with vacuum tubes, wave propagation (Chap. V), quartz crystals (Chap. X), and transmission lines (Chap. X). The discussion on transmitters in the last chapter is sketchy.

A careful revision and rearrangement of the book will enhance the value of a second edition. It may perhaps be better to avoid such expressions as "up in the air" (p. 201). Also "grid base" on page 185 should be "grid bias"

A feature of the book which is worthy of attention is the mathematical discussion of circuits and circuit behaviour. This is invariably good and helps a clear understanding of the problem under discussion. The authors are to be congratulated on this.

The printing and get-up of the book as also the figures and photographs are of the usual high standard for which the publishers are well known. The price is rather on the high side, but this is perhaps due to the prevailing war conditions. K. SREENIVASAN.

Radio Technique. By A. G. Mills. (Chapman and Hall, 11, Henrietta Street, London, W.C. 2), 1944. Pp. vii+170 with 301 figures. Price 12*s.* 6*d.* net.

This is one of the best books on radio engineering designed for the beginner and the author must be congratulated on it. It is brief, nonmathematical, terse and accurately written. The average legnth of a chapter is a little over 7 pages. The longest covers 22 pages and the shortest but 2 pages. In less than 170 pages, the author attempts to cover a very wide field, starting from the elements of the structure of matter, electricity and magnetism, through d.c. and a.c. machinery and measuring instruments, on to radio transmitters and receivers and even such a comparatively new subject as pulse generators, which have been developed and applied so extensively during this war. That his attempt has achieved this measure of success is because the author chooses his subjects carefully, sticks to a treatment of the essential principles, and is terse in his explanations without sacrificing accuracy and clarity. He knows his subject and can present it well. The reader has necessarily to go to other books for a more detailed and mathematical treatment. But to the beginner, the book can be recommended without reserve.

A chapter on frequency modulation and another on ultra-high frequency and microwave technique would have added to the value of the book. Perhaps this will be made good in the second edition. The book is free from errors, but the half waves in the damped wave train in Fig. 50 (p. 35) should be spaced equally; the frequency of damped oscillations does not change from cycle to cycle or over a cycle. The title of Chapter XIII may perhaps be changed to read "The valve as an oscillation generator".

Praise is due to Messrs. Chapman and Hall for the excellent production of the book. It adds to their reputation as publishers of technical literature. K. SREENIVASAN.

Hydro-Electric Power in India—A Geographical Analysis. By George Kuriyan. (The Indian Geography Society, Madras), 1945. Pp. 72. Price Rs. 2.

The booklet is the first of a series of Monographs published by the Indian Geographical Society, Madras, and compiles in a very interesting manner a good deal of information regarding water-power resources scattered in various reports published by the Provincial

Governments and by experts like Mr. Meares, Sir William Stampe, Sir Henry Howard and others.

The greatest need of the moment in India is the development of industries and power development is the *sine qua non* for industrialisation. The authors of the Bombay Plan have, therefore, rightly placed the production of power first in the list of basic industries. Unfortunately, as compared with other countries, India is severely handicapped with regard to natural supplies of coal and oil. Besides, as coal is absolutely essential for some of the basic industries such as iron and steel, cement, etc., it is imperative that every effort should be made to conserve our extremely meagre reserves, rather than utilize the same for the production of power. So that in India all developments of power will have to be mainly hydro-electric.

Fortunately, the potential water-power resources of India are indeed very great. On the basis of the Meares Triennial Report of 1922, our resources, even on the most conservative estimates, are about 12 million KW. But the developed resources so far constitute only 6 to 7 per cent. of the potential. The Bombay Plan suggests that the potential reserves are even as high as 27 million KW. Thus there is great scope for development.

The author, after first referring to the most salient geographical and economic features of some of the major hydro-electric schemes now in existence such as the Cauvery and Jog power schemes in Mysore, the three Tata schemes in Bombay, Pykara, Mettur and Papanasam in Madras, Pallivasal in Travancore, Mandi scheme in Punjab, the Ganges Canal Grid in the U.P. and Malakhand in the N.W.F., discusses very briefly some of the important potential reserves which lend themselves to immediate development. The following are some of the important schemes suggested as feasible for immediate development: KOYNA and KOLHAPUR projects in Bombay; MOYYAR and PERIYAR projects in Madras; TUNGABHADRA, GODAVARI and KRISHNA projects (irrigation and hydro-ellectric) in Madras conjointly with Hyderabad; MACHAND project in Madras conjointly with Orissa; JUMNA and SUTLEJ valley schemes in the North; DAMODAR valley, HUKONG valley and TISTA projects in the North-East. These alone would amount to about 3 million KW even on a very conservative estimate, and further expansion could be easily made as the demand for power increases.

The Indian Geographical Society, Madras, and the author, its Hon. Secretary, are to be congratulated in bringing out this useful and informative pamphlet at a time when India is about to enter upon a period of planned development. H. N. RAMACHANDRA RAO.

Colorimetric Determination of Traces of Metals. By E. B. Sandell. (Interscience Publishers, Inc., New York), 1944. Pp. 16 *plus* 487. Price $7.00.

The functional role of traces of metal is one of profound significance in several fields of pure and applied sciences. In the domain of biochemistry traces of iron, copper, manganese, magnesium, zinc and other metals influence the course of physiological reactions; some of them in fact constitute the prosthetic group of certain enzymes essential to their activity. In metallurgy, traces of metals like vanadium, molybdenum and tungsten influence the structure, mechanical strength and corrosion resistance of metals, especially those of steel. The influence of traces of metals on the growth and disease of resistance of plants is well known. These effects are controlled by the concentration of these trace constituents. A colorimetric determination of these important metals in traces when they occur in association with overwhelming quantities of other interfering materials is the problem which the author has lucidly set forth in the volume under review.

The book is divided into two parts: (1) The General Part comprises the principles and the scope of trace analysis, the methods of separation and isolation of the trace elements and the application of colorimetry and spectrophotometry including fluorimetry to the detection and estimation of the trace elements. This part also includes a discussion of the principal organic and inorganic reagents employed in this analytical field. The stability and the range of sensitivity of these reagents are given. (2) The second part deals with the analysis of individual elements; the presentation follows a certain pattern. To quote the author, "First the separation of the metal in question from other elements is considered, chief attention being given so far as possible to those likely to interfere in the colorimetric determination and to those frequently associated with the metal in question. For many metals, methods worked out specifically for the separation of traces are lacking and a brief general outline of separations is all that can be given, with the hope that some of these separations can be extended with suitable modifications to work involving small quantities. Next the important methods of determination are described. The procedures are given in general form so far as possible, independent of the nature of the original sample. The effect of foreign elements, so far as known, is mentioned. Finally, for many of the more important trace elements, directions are given for the determination of the metal in important classes of material". The volume is complete with examples of standard curves indicating the sensitivity and reproducibility of the method. The metals are arranged in the alphabetical order; this facilitates ready reference. An author and subject index completes the volume. The get-up is excellent in spite of war-time restrictions. This is an indispensable volume for not only to analytical chemists, metallurgists and biochemists, but also to the specialist interested in the elucidation of the catalytic role played by trace elements in plant and animal physiology. It is earnestly to be hoped that the author will in due course present to the scientific world an equally useful companion volume pertaining to the colorimetric analysis of non-metals.

Twenty Questions about Russia. By H. W. Henderson. (Hamara Hindustan Publications, Bombay), 1945. Pp. 56. Price As. 8.

Freedom of speech, of the press, of assembly, of street processions and demonstrations, in fact freedom in any form does not exist in the Soviet Union. Communists recognise the right to lie and cheat for the purpose of advancing their cause, the standard of living of the Russian worker was better under the Tsarist system than at present under the Soviet, inequalities exist as under the capitalistic system, Russian industry is run by a well paid bureaucracy and the workers have less control over industry in Russia than in any other country in the world, in fact in the Soviet Union the regime is patently a dictatorship OVER the proletariat, and not OF the proletariat.

These are some of the answers of Mr. Henderson—the author of *Twenty Questions about Russia*. As the Webbs have so aptly said in their well-known book on Russia, few other subjects in the history of human civilization have invited such bitter antagonists or ardent admirers as the "New Civilization" which the Comunist Party in Russia have been trying to develop in that vast country since the revolution in 1917. To assess the true value of this great experiment and its phenomenal development in the Soviet Union, one need neither go to bitter critics, to which class Mr. Henderson evidently belongs, nor to ardent admirers and blind enthusiasts. The monumental work of Sydney and Beatrice Webb, *Soviet Communism—A New Civilization*, which is at once accepted as an authoritative and scientific exposition of the working and achievements of the Soviet new institutions would serve much to furnish a comprehensive and dispassionate view of the Russian achievements. But passages from old articles and questionable sources picked at random without any reference to the subject as a whole, as evidently the pamphlet of the type under review can at best be, is injurious to the judgment of people who have either no inclination or no opportunity to go deep into the subject. Reactionary pamphlets of this type and organizations who publish them, ill-serve the people—the villagers of India—whom they ostensibly wish to 'enlighten'.

M. S. MUTHANA.

THE RIDDLE OF LIFE*

IN this little book based on a course of lectures given at Dublin, the author, Nobel Prize winner for Physics, and famous for his contributions to atomic dynamics, has ventured into the field of biology with the hope of throwing some light on the greatest of all problems confronting science—the ultimate nature of life. In these days of excessive specialisation, it requires no little courage for a physicist to venture outside his own field and put forward his ideas on other subjects. Professor Schrödinger is, however, not a specialist of the conventional type. Besides being a mathematician and a physicist, he is also a philosopher, with an original and distinctive outlook on the fundamental problems of science. Anything he says or writes can naturally, therefore, claim the attention and interest of all thoughtful persons.

During the present century, great advances have been made towards an understanding of atomic and molecular structure, and towards an elucidation of the manner in which atoms and molecules join up to form the aggregations familiar to us as various forms of matter. Our ideas regarding the building up of atoms and molecules from the elementary particles of Nature are based on the principles known comprehensively as the "quantum theory". It is the quantum theory which enables us to understand why atoms and molecules have a stable structure, and why, again, a crystal when formed possess an inherent stability and a definite temperature of melting or transformation.

Professor Schrödinger's main idea set out in these lectures appears to be that the quantum theory may also furnish us with the key to the riddle of life. One of the most remarkable features of life at all its levels is its inherent stability, as shown by the permanence of the characters exhibited by a species when it reproduces itself from generation to generation. Modern biological research has established the intimate relationship between this inherent stability and the ultimate structure of the living cell, and especially of the parts of it known as the chromosomes. It has also established the fact that changes in these structures accompany a mutation of the species either occurring naturally or when artificially induced. These facts become intelligible if we regard the genes as distinct molecular species which can only be altered by "quantum jumps".

Professor Schrödinger has also some interesting suggestions to offer regarding the relation between the fundamental principles of thermodynamics, and the processes by which life functions, including especially the consumption and assimilation of food.

The book is both an attractive and a stimulating production.

C. V. RAMAN.

* *What is Life?* by Erwin Schrodinger, pp. viii + 91, 6 *sh.* net, Cambridge University Press.

THE ACADEMY OF SCIENCES, U.S.S.R.

The Academy of Sciences of the U.S.S.R. is holding the celebration of its 220th anniversary from the 15th to the 28th of June 1945. Invitations have been extended to the foremost scientists in all allied countries. Professor Meghnad Saha, F.R.S., according to Reuter, has safely arrived in Moscow to participate in the celebrations.

SCIENCE NOTES AND NEWS

The Trustees of the Lady Tata Memorial Trust announce on the death anniversary of Lady Tata, which falls on the 18th June, the awards of the following scholarships and grants for the year 1945-46:—

I. International Awards for research in diseases of the blood with special reference to Leucœmias :

(1) Dr. P. A. Gorer, London—Grant £70; (2) Dr. A. H. T. Robb-Smith, London—Grant £100; (3) Dr. Werner Jacobson, Cambridge—Grant £300; (4) Dr. (Miss) P. Hammick (to work under Prof. Witts to confirm Dr. Jacobson's research)—Grant £400.

II. Indian Scholarships of Rs. 150 per month each for one year from 1st July 1945 for scientific investigations having a bearing on the alleviation of human suffering :—

(1) Mrs. Alamela Venkataraman, B.A., M.Sc. "Synthesis of Sulphanilamide Derivatives." (Haffkine Institute, Bombay.) (2) Mr. S. Dattatreya Rao, B.Sc. (Hons.). "Investigations on the Synergy between Vitamins A and E and Functions of Carotene and Vitamin A in the Animal System." (Indian Institute of Science, Bangalore.) (3) Mr. L. D. Sanghvi, B.Sc. (First Class), M.Sc. "Genetical Study of Blood Groups and Diseases with Special Reference to Malignant Tumours and Erythroblastosis Fœtalis in Bombay." (Tata Memorial Hospital, Bombay.) (4) Mr. T. A. Venkitasubramanian, B.Sc. "Synthesis of Anti-parasitic Agents against Tropical Diseases other than Malaria with Special Reference to Amædines and Organometallic Compounds." (Maharaja's College, Ernakulam.) (5) Mr. G. Balasubramanyam, M.Sc. (First Class). "Insulin Derivatives and Carbohydrate Metabolism." (Indian Institute of Science, Bangalore.) (6) Mr. T. K. Wadhwani, B.Pharm. "Mechanism of the mottling of teeth." (Indian Institute of Science, Bangalore.) (7) Mr. Rabindra Kumar Basu, M.Sc. "Synthesis of Vitamin C (1-Ascorbic Acid)." (University College of Science and Technology, Calcutta.) (8) Mr. Kalipada Mukherjee, M.Sc. "Research on Food Yeast." (Biochemical Laboratories, University of Dacca, Dacca.)

The first annual sessions of the Ceylon Association of Science, inaugurated in July last year, was held in the University Hall, Colombo, from May 17th to 19th and was largely attended by all leading scientists in the Island.

The General President, Dr. D. N. Wadia, former Government Mineralogist, Ceylon, and now Mineral Adviser, Department of Planning and Development, New Delhi, was unavoidably absent and his presidential address on "Science in Ceylon's National Life", was read by the President-elect, Prof. W. A. E. Karunaratne.

In a message sent to the Annual Sessions, H. E. the Governor stressed the Contribution of Science to World Peace and wished all success to the Association.

The sessions was declared open by Mr. C. W. W. Kannangara, the Minister of Education and Pro-Chancellor of the Ceylon University. This was followed by a symposium on "Science and National Development", initiated by Dr. Andreas Nell.

As in India, Science Congress Sessions sectional or intersectional meetings were held in the mornings and visits were arranged to centres of scientific interest in Colombo in the afternoons. The last item of the programme each day was a popular lecture.

Prof. A. Kandiah, Acting Vice-Chancellor, University of Ceylon, was elected President and Prof. W. A. E. Karunaratne, the new General President.

The decision of the University of Aberdeen to confer an honorary degree of Doctor of Laws (LL.D.) upon Mr. Stanley Unwin, the publisher, sets an interesting precedent. On the Continent, it has long been the practice of Universities to encourage outstanding work by publishers in the interests of scholarship. But if one excludes those occasions when a University has recognised in this way someone connected with its own Press, this represents, we believe, the first time a publisher has been so honoured in Great Britain. It is pleasing evidence of that improved status of books, which Mr. Unwin has himself done so much to achieve Mr. Stanley Unwin is the owner of the firm of George Allen & Unwin Ltd., Chairman of John Lane, the Bodley Head Ltd., and a director of Methuen & Co., Ltd. He is a past President of both the Publishers' Association of Great Britain and of the International Publishers' Congress and comes from a family long connected with printing and publishing. As President of the International Publishers' Congress in 1936 it was his duty to present the principal foreign delegates to King Edward VIII at Buckingham Palace.

SEISMOLOGICAL NOTES

Among the earthquake shocks recorded by the seismographs in the Colaba Observatory, Bombay, during the month of May 1945, there were two of slight intensity. The details for those shocks are given in the following table:

Date	Time of origin I.S.T.	Epicentral distance from Bombay	Co-ordinates of epicentre	Remarks
	H. M.	(Miles)		
9	10 05	2410	..	Probably deep.
19	11 33	1310	..	Epc : In Assam.

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